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Agricultural Research

Research: Why Invest Now?

The 1970's view of a world unable to feed growing populations has given way to concerns about surplus production in many developed countries. Much of the rapid growth in output can be attributed to advancements spawned by scientific research, including changes in farm machinery, pesticides, and plant and animal genetics.

U.S. agricultural productivity is expected to grow 1.5 to 2 percent per year for the next 10 years. Output could increase 40 percent by the 1990's if these productivity gains are combined with the cropland currently idled and the gradual conversion of 20-30 million acres of land suitable for cropping but not now used.

Because of their traditional emphasis on expanding output, coupled with budget constraints, agricultural science and technology programs have come under increasing scrutiny.

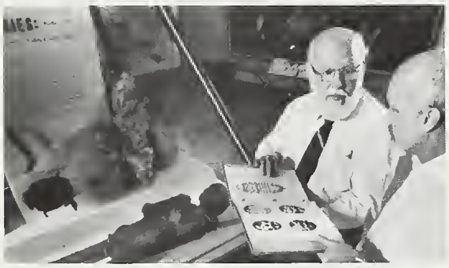
The economic climate in the world poses several challenges to the traditional rationale for support of agricultural science and technology in developed countries. Why should governments and industry continue to fund agricultural research in the face of food surpluses, tight budgets, and falling demand? There are many good arguments for maintaining a strong agricultural science and technological capacity, including:

- *Maintaining productivity growth:* Growth in productivity and efficient use of resources are the primary means of improving the benefits to society. Increased productivity assures more output from available land, water, and other resources. If demand is not growing fast enough to absorb productivity gains, resources can be transferred from food production to other uses. By using fewer resources, costs and the proportion of society's income required to meet basic food and agricultural needs will be lower. In fact, if productivity levels in developed countries were the same as in 1950, food would take nearly twice its current share of disposable income.
- *Coping with declining supplies and rising costs:* The supplies of many resources including fertilizer, minerals, ore, petroleum, and nonrechargeable groundwater pools, are fixed. Eventually, agriculture must adjust to the loss of some of these resources or to their increasing costs as supplies dwindle.
- *Developing renewable raw materials:* Another side to the depletion of stock resources is the possibility of developing new uses for agriculture's productive capacity. One prospect is using agricultural products as renewable resources. Biomass fuels, such as ethanol, may eventually become more economical, and industries could turn to agriculture for other renewable raw materials. Agriculture could become proportionally less of a food industry and more a supplier of industrial raw materials. Such developments provide new opportunities for farmers and a way for the world to adapt to limited supplies of some stock resources. Agricultural research will need to play a lead role in the development of these new products.
- *Improving the quality of products and processes:* With food and fiber in plentiful supply in developed countries, there is an opportunity to shift the focus of some research to the quality of production. This includes research towards efficient use and conservation of resources. Other examples include increased energy efficiency; less ecologically damaging technology; techniques that makes more efficient use of water, mineral nutrients, and other limited resources; and foods that are tastier, more nutritious, and safer for human consumption.
- *Meeting the food needs of developing countries:* Despite excess supplies in most developed nations, many countries still suffer food shortages. The developed world has a vested interest in assisting the developing countries. Stronger economies for many of these nations, including the agricultural sectors, could improve chances for global political stability and greater market potential for the growing agricultural capacity of developed countries.
- *And maintaining flexibility to deal with an uncertain future:* Considerable uncertainty surrounds the scenario of plentiful food supplies, especially beyond the next decade or two. Unforeseen natural, economic, or political shocks could change the outlook. Without ongoing investment in science and education, continued productivity growth cannot be assured. With food security, it is preferable to err on the side of surplus rather than shortage.

[The above are excerpts from a statement by John E. Lee, Jr., Administrator of the Economic Research Service.—**Ed.**]

Agricultural Research

Cover: A collection of forest-devastating gypsy moths helps ARS entomologist Ronald Hodges identify specimens submitted to the Systematic Entomology Laboratory. The Laboratory is operated in cooperation with the Smithsonian Institution's Museum of Natural History where about 30 million specimens are stored in the National Insect Collection. Story begins on page 7. (1185X1256-4A)



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Aiming for a Chick's Genetic Blueprint

Ironically, the virus that causes avian leukosis may be used someday as a carrier for an inherited resistance to the disease.

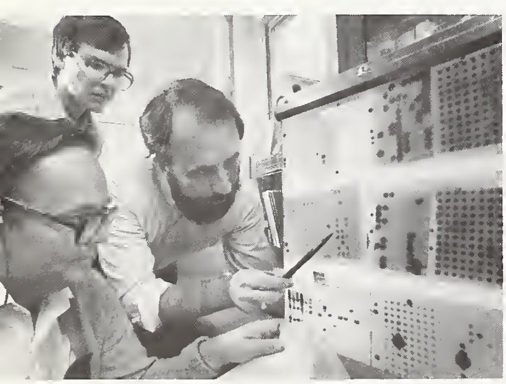
Although the tumor-causing disease kills only 1 to 2 percent of infected chickens, those that survive produce about 10 percent fewer eggs.

Viruses have already been used to carry genes into the chromosomes of plants and mice. But Lyman B. Crittenden, an Agricultural Research Service animal geneticist in East Lansing, MI, says no one has ever done this with chickens.

Crittenden says he and microbiologist Donald W. Salter and other colleagues are taking a first step toward adding desirable genes in chickens—inserting avian leukosis virus into the genetic material in the reproductive cells of fertilized chicken eggs so it will be passed on to future generations.

Crittenden says he has "very good preliminary evidence" that he will succeed.

The real proof comes after the injected eggs hatch, the chickens mate, and the new chicks are found to have inherited the virus genes.



Animal geneticist Lyman Crittenden (left), technician Kent Helmer, and microbiologist Donald Salter (right) evaluate autoradiograms of avian leukosis-infected chicken blood. Through these studies, Crittenden and his associates hope to identify chickens with avian leukosis genes in their DNA. (1185X1252-33)

If the first step succeeds, scientists will still face years of work before they can attach other genes to the virus for resistance to various chicken diseases or for rapid growth. One task they would face is deactivating the virus genes so they do not produce the virus.

Lyman B. Crittenden is at the USDA-ARS Regional Poultry Laboratory, 3606 East Mt. Hope Road, East Lansing, MI 48823. ■

Meat Quality Forecast for Buyers

A new test tells how long hamburger will stay fresh until it is finally sold in supermarkets or used in fast-food restaurants.

Ground beef sold in bulk can now be tested by buyers for restaurants, supermarket chains, and the military—before they buy—to quickly estimate the shelflife, says Agricultural Research Service chemist A. Douglas King, Jr.

The analysis is superior to other methods for detecting early spoilage of hamburger because it is less expensive, more accurate, and faster (it only takes 1 hour).

Further, it's more convenient. The test can be run on an instrument—a high-performance liquid chromatograph—that is readily available at most commercial laboratories, says King.

Other methods either take too long (one test takes 5 to 9 days) or for other reasons are impractical, according to King. He and former ARS researcher Patricia Nassos-Stalder developed the new technique.

The analysis measures lactic acid, a compound that occurs naturally in animals and is also produced by bacteria. High levels of lactic acid indicate the beef will spoil quickly.

King says buyers can use test results either to determine how much longer they can safely store the meat, or to reject the beef outright.

The test is used in the first stage of processing ground beef. The meat is coarsely ground, then kept refrigerated in large, oxygen-free plastic bags until needed, which may be as long as several weeks. (Later, when a supermarket or other outlet buys these "chubs" or "keeper" packs, the coarse grind is converted to the familiar "fine grind," which has a much shorter shelflife.)

Bacteria that produce lactic acid thrive in the oxygen-free pack, and—at low levels—are probably beneficial. But lactic acid can build up—if the beef is kept in oxygen-free storage too long—and can cause what's known as sour odor spoilage.

King and Nassos-Stalder have patented their invention.—**Marcia Wood,** Albany, CA.

A. Douglas King, Jr., is at the USDA-ARS Western Regional Research Center, 800 Buchanan St. Albany, CA 94710. ■

American Elm—More Than a Lone Survivor

Mass plantings of American elms set the stage for the Dutch elm disaster beginning in the thirties.

The fungus came from France, in wood shipped to the east coast. Within 4 or 5 years, scientists could retrace the wood's trip by looking at elm trees. The trail ran along railroad tracks to furniture factories in Cleveland and Columbus, OH.

Lawrence R. Schreiber, research leader of USDA's Agricultural Research Service Dutch elm disease center in Delaware, OH, has spent 25 years searching for survivors with genes for a strong resistance to the fungus.

Schreiber and his colleagues search for trees on their own and sometimes get calls from people with an ancient survivor in their yard.

When a tree is selected for

When photographed in 1960, stately American elm trees formed a shady canopy over this flagstone walk on the campus of Pennsylvania's Swarthmore College. Several years ago, Dutch elm disease destroyed all but a few of these trees. (Photograph by Grant Heilman)

study, the scientists send someone to cut fresh shoots as near the top as possible, sometimes using an especially high-reaching cherry picker.

When they return to the lab they try to get the shoots to root. Then the shoots that do grow are deliberately inoculated with Dutch elm disease fungus to find out if this tree was really special or just another lucky one.

Schreiber says it's not uncommon to find a single elm surviving by chance where others have died. Nor has the American elm gone the way of the American chestnut. Schreiber estimates there are still hundreds of thousands to millions of American elms growing in this country.

So far, all but a handful of those tested have turned out to be just lucky, with no genetic resistance. Even those with resistance do not measure up to European and Asiatic elms, which have genes for strong resistance.

The Ohio lab has released three selections of elms resulting from breeding work with European and Asiatic elms, led by plant geneticist A.M. Townsend. In 1984, Townsend and the breeding part of the Dutch elm program moved to the U.S. National Arboretum in Washington, DC.

Why not cross the American elm with its resistant European and Asiatic cousins? It's impossible, Schreiber says, because the American has double their number of chromosomes.

That's why Schreiber is considering bypassing conventional breeding by fusing protoplasts (cells without walls) from the American elm with other resistant species.

Until an American elm is released for sale, people will have to settle for European and Asiatic elm varieties adapted to look more like the American elm.—**Don Comis,** Beltsville, MD.

Lawrence R. Schreiber is at the USDA-ARS Nursery Crops Research Laboratory, 359 Main Road, Delaware, OH 43015. A.M. Townsend is at the USDA-ARS National Arboretum, 3501 New York Ave., NE, Washington, DC 20002. ■

Low-Salt Soy Sauce Tastes Just as Good

Removing salt from soy sauce and similar foods can help people who like these foods maintain the correct ratio of sodium to potassium in their diets.

Tests of a new process show the sauce retains its rich flavor after sodium content is cut 50 percent and potassium is increased as much as five times, says Wayne Camirand, an Agricultural Research Service chemist at Albany, CA. He now has a patent for the invention. (See page 16.)

The technique comes at a time when Americans are not only continuing to get about twice the recommended amount of salt but are also not getting the proper balance of potassium to sodium. The recommended ratio for these two minerals is about two to one (twice as much potassium to sodium) but many people get just the opposite—too much sodium in relation to potassium.

High salt intake has been linked to high blood pressure (hypertension), a condition that affects one out of every five Americans over age 25. Imbalances in the body's potassium-sodium supply may contribute further to this condition.

The new technique works "not only for soy sauce but for other high-salt, fermented liquids as well, including oriental fish sauce and tamari sauce," says Camirand.

The process is simple and inexpensive: A stream of sauce is forced through a series of curved channels; alongside it, a stream of potassium chloride solution is pumped in the opposite direction.

The two flows are separated by a special barrier which allows cations (positively charged particles) of sodium to move out of the soy sauce and into the potassium. Similarly, potassium cations can flow from their solution into the sauce. All other particles are blocked.

The exchange can be interrupted when the mixture reaches the desired level of sodium but still retains a distinctive soy flavor. Sauce that's too low in sodium probably won't pass taste tests; a blend too high in potassium has the natural bitterness of this mineral.

Salt is needed to kill any harmful micro-organisms that might develop during the long, slow fermentation process. Later, the salt serves as a preservative. Potassium interferes with fermentation, so can't take the place of salt during that stage. However, once the sauce is fermented, potassium can substitute for sodium as a preservative.—**Marcia Wood,** Albany, CA.

Wayne M. Camirand is at the USDA-ARS Western Regional Research Center, 800 Buchanan Street, Berkeley, CA 94710. ■

Screen Test for Bad-Acting Bees

A 1-minute screening of wing size in a field laboratory can tell a honey bee from an Africanized bee.

Agriculture inspectors are already using the test in California, where a swarm of Africanized bees (sometimes called killer bees) was found for the first time in the United States.

Wing measurements give biological aide John Hogen, Bioenvironmental Bee Laboratory, Beltsville, MD, a way to quickly spot Africanized bees, so-called "killer bees." (0985X958-21)

The California Department of Food and Agriculture and USDA's Animal and Plant Health Inspection Service are testing about 10,000 commercial hives in that state.

Officials elsewhere can use the test to make sure Africanized bees are truly on the loose before they risk eliminating bee colonies, says inventor Thomas Rinderer. Rinderer is research leader of the Agricultural Research Service's Bee Breeding and Bee Stock Laboratory, Baton Rouge, LA.

Rinderer noted that officials want to protect domestic honey bees, which closely resemble Africanized bees, because they are vital to American agriculture. Over $18 billion worth of crops are pollinated by honey bees every year.

Africanized bees received their bad name because they are far more aggressive and likely to sting than domestic honey bees, although they do not have a sting that is any more toxic.

Rinderer and colleagues are using the new test at the Baton Rouge laboratory to identify samples shipped from California.

Bees are first screened in a 1-minute procedure: The forewings of 10 randomly selected bees from a suspect colony are mounted on slides, projected onto a screen, and measured.

Wing sizes are then checked against a numbered chart that has pre-established measurements for each kind of bee.

However, if there is still a suspicion that the bees are Africanized, further testing begins.

First, the researchers weigh the bees and measure their hind wings and legs. Next, they enter data on all the measurements into a computer, which then gives a figure indicating the probability that the bees are Africanized.

"We call the test FABIS (Fast Africanized Bee Identification System) and it can be taught to state and local technicians in only 1 day," says Rinderer.—**Jessica Morrison,** formerly at Beltsville, MD.

Thomas E. Rinderer is at the USDA-ARS Bee Breeding and Bee Stock Laboratory, 1157 Ben Hur Road, Baton Rouge, LA 70820. ■

Cultured Fibers Boost Cotton Gene Research

For the first time, cotton fibers have been grown in the laboratory directly from cells without growing any other part of the plant.

In the spring of 1985, a team of scientists at Texas Tech University, Lubbock, who were trying to grow whole cotton plants from cells in a nutrient solution, found that some of the cells had become cotton fibers.

The Agricultural Research Service, which partially funded the Texas Tech research, suggested further work to improve the nutrient solution so more cells would become fibers. The scientists have now patented a medium that induces most cells to develop into fibers.

An early beneficiary of this finding will be the recently established Cotton Quality Regulation and Alteration Research group at the ARS Southern Regional Research Center in New Orleans, LA.

Members of the new unit, including plant molecular biologist Barbara A. Triplett, will work closely with other scientists at the Center doing cotton fiber research.

Triplett says the research team will seek a basic understanding of how fiber forms. She says the cell culture technique will make this work much easier since the group will have a constant supply of cells all performing the same biochemical processes.

One of the first tasks, she says, will be to find out if the fiber formed from cells is the same as that formed in cotton plants.

Triplett stresses that she can see no commercial potential to growing cotton in a laboratory rather than a field. She says it's very expensive and the yield is low.

Rather, she sees the technique as a research tool to learn enough about fiber to be able to genetically alter it and eventually improve its quality.

The textile industry would like to have cotton fibers that are longer, stronger, of uniform size, and with properties that will help processing, including dyeing and finishing for permanent press fabrics.—**Don Comis,** Beltsville, MD.

Barbara A. Triplett is at the USDA-ARS Southern Regional Research Center, P.O. Box 19687, New Orleans, LA 70179. ■

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Name That Insect!

On August 1, 1983, Michael P. Malone of the FBI Laboratory in Washington, DC, hand-carried a plastic vial containing several insect specimens across the Mall to the Smithsonian Museum of Natural History building. He was bringing them to the Agricultural Research Service's Systematic Entomology Laboratory (SEL) to determine whether they were native to the United States or of foreign origin.

A few days earlier, the FBI had been called in on a $2.9 million electronics theft. Twenty-six cartons of integrated circuits airshipped from an assembly plant in Malaysia through San Francisco airport to several destinations in the western United States had been broken into. The insects, a few pieces of wood to add weight, some substituted packing material, and a soil sample were the only clues.

SEL's Robert V. Peterson distributed the dead specimens—a fly, a biting midge, and two ants—to the appropriate entomologists for identifications.

The fly was too badly mashed to determine its homeland. The ants proved to be a common species that could have invaded the boxes anywhere between Malaysia and their final destinations. But the biting midge was identified as a species common to Asia and unknown in California. The identification, together with the FBI lab's finding that the wood was not native to America, pointed to Malaysia as the probable site of the theft, according to Malone.

The roots of the Systematic Entomology Laboratory (SEL) go back before 1862 when Congress established the Department of Agriculture and provided for an official entomologist. Now part of USDA's Agricultural Research Service, the laboratory has 28 entomologists, 9 technicians, 5 artists and clerks, and 5 dedicated retirees who continue their own research and help with the 170,000 insect and mite specimens that are sent to the laboratory each year for identification.

To identify a butterfly, entomologist Mike Schauff selects comparison specimens from the more than 4 million specimens of Lepidoptera stored in approximately 35,000 drawers in the National Insect Collection. (1185X1257-33A)

Most of the staff is housed at the Smithsonian museum, while 6 entomologists and laboratory chief Douglass R. Miller have their offices about 15 miles away at the Beltsville (MD) Agricultural Research Center.

Raymond J. Gagne, SEL's specialist in flies that lay their eggs in dead animal tissues, is sometimes called on by the FBI or state and local police to estimate the time of death of a suspected murder victim. Different species of flesh flies will invade a body at different stages of decomposition, he explains, and the larvae of each species develop at predictable rates. His reports generally corroborate the medical examiner's, he says.

Playing detective is only a small part of Gagne's work. He estimates he receives about one ID request per month to support criminal or civil investigations but spends about one-quarter of his time on ID's for research and quarantine.

The rest of his time is devoted to his own research on gall midges—there are about 1,000 known species in North America alone.

How does one become so skilled at distinguishing insect species? By the science of taxonomy—the classification of organisms in an ordered system designed to indicate natural relationships.

Taxonomists find differences in gross characteristics—size, shape, coloring, sculpturing on the body, arrangement of veins in wings—and internal differences, particularly in the genital organs. "With some parasitic wasps," says entomologist Paul M. Marsh, "this is quite a task. The specimens are often as small as the head of a pin."

The tools of a taxonomist's trade have traditionally been a collection of specimens, a reference library, a light microscope, and drawing implements, but SEL scientists also use a scanning electron microscope that produces three-dimensional photos and a computer-assisted image analyzer to make and compare minute measurements of

Entomologist Paul Marsh chooses highly detailed scanning electron micrographs of parasitic wasps to illustrate an identification manual. (1285X1375-9)

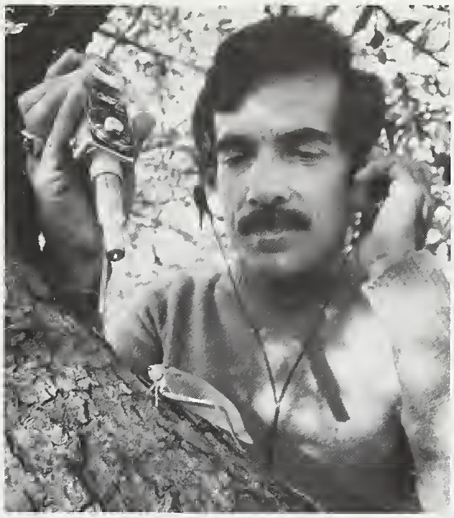
Above, top: Larvae shipped from a Florida hospital to the Systematic Entomology Laboratory are examined by entomologist Robert Peterson (foreground) and retired entomologist George Steyskal. As Florida doctors suspected, the larvae are intestinal parasites of the Psychodidae family (moth fly). The moth fly can give people leishmaniasis, a tropical disease which eats away at flesh. (1285X1361-33)

Above: After extracting resin midges from a pine twig, entomologist Raymond Gagne will examine them under a microscope for more positive identification. Resin midges destroy conifer seeds, causing expensive losses in areas set aside for seed production. (1285X1345-26)

insect parts, such as veins in the wings of Africanized bees. The image analyzer is similar to a machine used by police for high-speed identification of fingerprints.

ARS entomologist Akey C.F. Hung, who works with SEL entomologists, is delving into insect cells with a gas chromatograph, looking for chemical "fingerprints" among the chromosomes and enzymes that can be used to sort insects into their evolutionary slots.

In addition, taxonomists rely heavily on field entomologists to supply information on an insect's habitat, its seasonal distribution, its preferred hosts—whether plant,



Above: Because individual species of crickets and katydids often appear so similar to one another, entomologist David Nickle confirms identifications by recording and analyzing their mating songs. (1285X1354-14)

animal, or other insects—and any other helpful information. You might say the taxonomist provides the "charcoal sketch," while the field workers provide the "modus operandi."

In the case of crickets and katydids, it's the mating song that confirms their identity. According to entomologist David A. Nickle, individual species often appear so similar to one another that they are difficult to identify through observation alone.

Nickle keeps live insects in his lab and works with a tape recorder. "The males call their mates by rubbing their wings together," he explains, "and each species has a distinctive song depending on how fast the wings vibrate." In fact, he has become so adept at mimicking the males of one species of katydid that the females flock to him.

Nickle and his SEL colleagues operate on an annual budget of about $2 million and quietly chip away at their prodigious task: to develop classification systems for insects and mites important to agriculture and to develop a storage and retrieval system for the mass of information accrued over the 100-plus years USDA has been gathering it.

The combined USDA-Smithsonian library is among the most complete reference libraries on systematic entomology in the world, says Lloyd Knutson, director of the institute that oversees the SEL and one of the 28 entomologists himself.

In return for office space at the Museum, the staff curates three-fourths of the Museum's entomology collection—more than 25 million insect and mite specimens. Each year, they add about 50 thousand of the specimens that come in for identification to the Smithsonian's permanent collection.

In addition, the SEL laboratory is computerizing a catalog of North American beetles, another of the 100,000 flies of the world, and a complete profile of each of the estimated 3,000 insects, mites, and related arthropods that have immigrated to North America. Much of the information for the Western Hemisphere Immigrant Arthropod Database is scattered throughout the continent in private and public collections and in unpublished records and will have to be gathered before entering in the database.

The scientists rely on this vast reservoir of information to provide the identification service—the sole federal unit providing such a service.

Millions of dead insect specimens flow through various identification services around the country each year. A large percentage of the toughest ID cases eventually wind up in the SEL, says Knutson.

A handful of specimens make their own way into the Museum . . . uninvited, says entomologist John M. Kingsolver. He has identified several species of dermestid beetles that are gnawing away at the insides of animal exhibits. The beetles have also collapsed the leather seat of an ancient sedan chair and were found invading a mummy on the second floor.

From his sixth-floor office overlooking the Mall, Kingsolver has also helped to probe antiquity. He identified a 1,900-year-old beetle that had been preserved within a haystack at

Along with Systematic Entomology Laboratory Chief Douglass Miller (right), Lloyd Knutson, director of the Biosystematics and Beneficial Insects Institute of which SEL is a part, examines computer printouts from one of the Institute's many databases—in this case, a catalog of flies of the world. (1285X1360-9)

an archaeological site near Naples, Italy. The site was buried by the same volcanic eruption that covered Pompeii.

Except for the few unusual requests, SEL entomologists concentrate on agriculturally related identifications. Users of this service are involved in biological control, ecological studies, and other research, extension, and regulatory activities of government agencies and private organizations.

A major user is a division of USDA's Animal and Plant Health Inspection Service which is responsible for keeping alien insects out of the United States and for tracking the movement of pests like the gypsy moth within its borders. Inspectors stationed at every port of entry thoroughly inspect each foreign shipment for possible stowaways. If they find any species on their "wanted" list, they have the cargo fumigated before it touches U.S. soil. But fumigation is costly to the shipper. When there is some question on an insect's identity, the specimens are rushed to the SEL via express mail for positive identification.

Every day in port costs the shipper money, particularly when the cargo is fruit or flowers. But the loss is miniscule compared to the havoc an alien insect can wreck once inside this country. Immigrant species—the boll weevil, for example—are responsible for about half of the insect-caused losses to U.S. agriculture.

Entomologist Donald M. Anderson leads the lab in *urgent* ID's, handling half of the more than 2,000 urgent requests each year. He specializes in bark beetles and beetle larvae, which are often found in imported lumber and wood products as well as on the packing crates and pallets used for shipping just about any commodity.

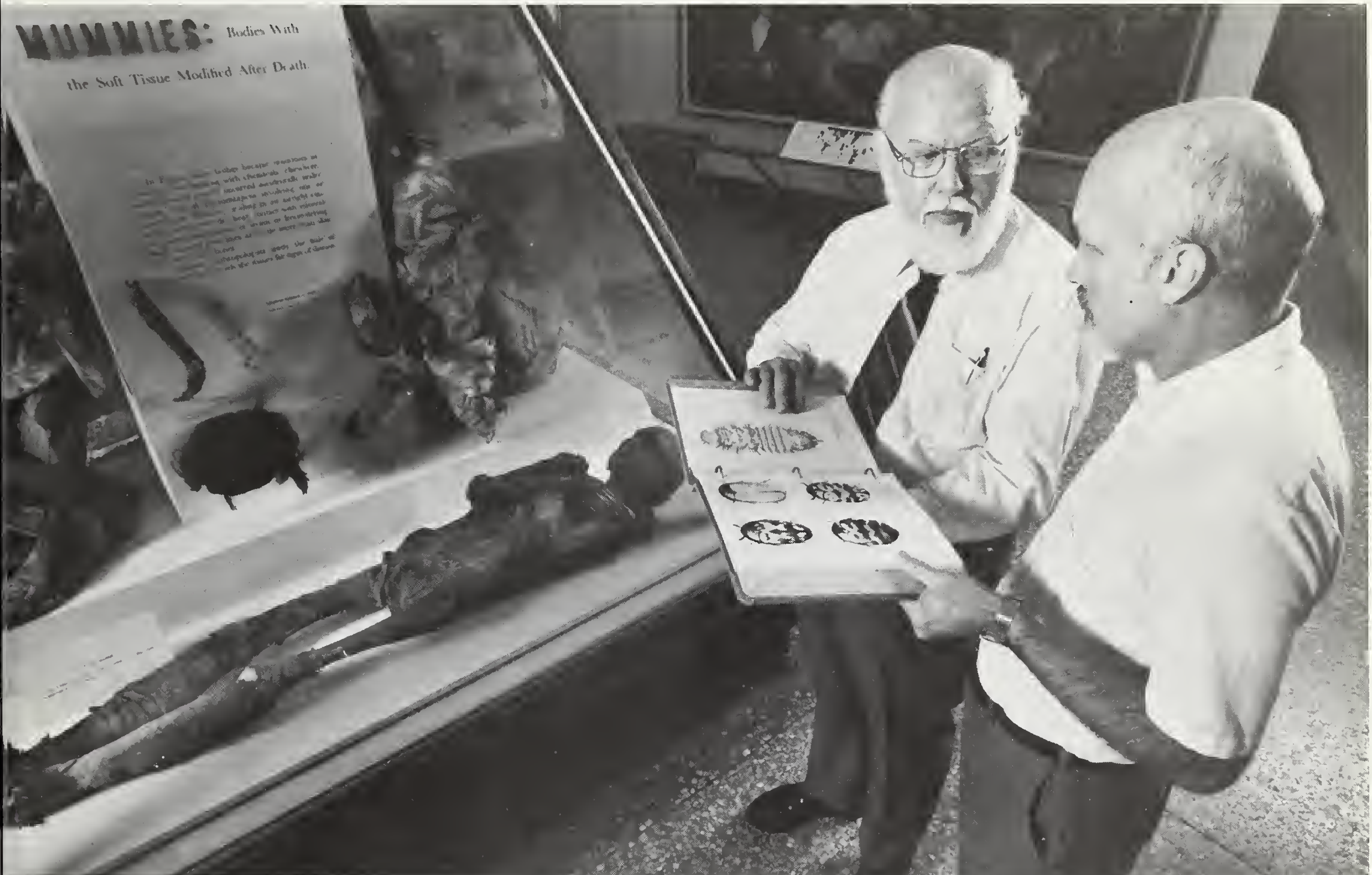
Kingsolver also scores high in *urgents,* particularly for the infamous khapra beetle—the most persistent pest of stored grain in the world. The khapra hails from the hot dry subcontinent of India, he says, but its larvae can adjust to extremes in climates by actually reversing their growth cycle. And because they have a penchant for squeezing into tiny crevices, they can come through a fumigation unscathed. The khapra has sneaked into this country several times this century and has been eradicated as often, he says, but it is a constant threat.

Despite this vigilance, 25 to 30 new insect species enter the United States each year, often with drug traffic or through other illegal channels. One or two of them will become major pests. To hold the number to a minimum, SEL scientists send reference collections of pest insects not known to occur in the United States—or PINKTO, for short—to federal and state inspection stations around the country. The collections include more than 70 species—each displayed in its full life cycle from egg to adult.

"For every insect alive, there are at least two or three insect species that feed on it," says Nickle, who recently tracked three species of mole crickets back to their native Argentina. The crickets, like many other alien pests, came to this country during the eighteenth and nineteenth centuries, entrapped in the ballast of sailing ships. When the crew dumped the dirt, sand, or gravel onto American shores, the insects found a suitable new home. And like most other imported pests, "the crickets arrived in this country without their complement of natural enemies," Nickle says. Knowing where to look for these enemies is the first but very important step in any biological control program, he emphasizes.

Marsh, a specialist in parasitic wasps, strongly concurs. He cites the gypsy moth problem to illustrate the need for good taxonomic groundwork. Since the early 1900's, nearly 50 species of natural enemies had been imported to control the pest with little success.

Marsh and others launched studies on parasitic wasps and flies whose females deposit their eggs in gypsy moth larvae, killing the caterpillars.



Entomologists John Kingsolver (left) and Don Whitehead discuss drawings of dermestid beetles discovered eating this Egyptian mummy and identified by Kingsolver. The mummy is now on display at the Smithsonian Institution's Museum of Natural History. (1285X1373-27)

The search turned up a number of promising parasites that have since been brought to this country and released. Whether or not they become successful weapons in the battle against the gypsy moths remains to be seen, says Marsh, "but it does show how even a limited taxonomic study can be very useful."

"Insects are so numerous, and we truly know very little about them," says entomologist Ronald W. Hodges. Add to that, he continues, the fact that each insect has several life stages—an egg, four to seven larval stages which can appear quite different from one another, a pupal stage, and finally, a male and female adult that often do not look alike—and one can begin to see the problem.

Hodges' interest is the moths whose caterpillars are the most insatiable crop pests. He specializes in a superfamily of moths that contains nine separate families. One of the families has 180 known species in North America, 131 of which Hodges has described himself. Among moths, he says, that family is no bigger than the gnat's eye. He is now tackling a family whose best known member is one of the cotton farmer's insect nemeses—the pink bollworm. Within the next 20 years, he expects to describe 1,000 new species in this family of moths alone. "That is more than all the species of North American birds combined," he notes.

Describing new species is only part of the task. Taxonomists must also work backwards over the 200 years the system for classifying insects has been in use and sort out duplications. Because of language barriers and slow communications, several entomologists have described the same "new" species unaware that it had already been named.

Discounting these aliases, about 1 million species of insects and mites have been described so far. Estimates of the total number of species range from 3 to 30 million. Scientists with the SEL and their counterparts around the world will be kept busy for centuries to come.—**Judy McBride,** Beltsville, MD.

Lloyd Knutson is at the USDA-ARS Biosystematics and Beneficial Insects Institute, Building 003, BARC-West, Beltsville, MD 20705. ■

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An Oilseed Crop With Promise

Cuphea, a relatively unknown plant outside the scientific community, might someday provide valuable oils for manufacturing soaps, detergents, surfactants, and lubricants and may have medical, nutritional, and dietetic applications as well.

In 1960, Agricultural Research Service scientists at the Northern Regional Research Center, Peoria, IL, discovered that unique properties of oils found in its seed make cuphea a potentially valuable new crop for the United States. Cuphea seed contain large quantities of medium-chain fatty acids such as lauric acid, which is used in manufacturing soaps and detergents. Other medium-chain fatty acids in cuphea can be used for clinical treatment of rare human ailments associated with fat absorption.

Geneticist Anson Thompson emasculates cuphea flowers before crossing with other cuphea species as part of his hybridization program. (0985X1007-21A)

Current supplies of these chemicals come from coconut and palm kernel oils, but cuphea seed may be a better source. For example, some cuphea seeds contain up to 42 percent oil, with lauric acid as high as 85 percent of the total. Coconut oil only contains around 45 to 50 percent lauric acid.

During the past few years, the United States has imported annually about 500,000 tons of these oils, costing about $250 million. Because of wide fluctuations in their supply and price to industry and consumers, ARS is now taking a closer look at cuphea.

Anson E. Thompson, ARS plant geneticist at Phoenix, AZ, heads a research project to develop cuphea as a new crop for this country.

"Currently, cuphea's major shortcomings are excessive seed shattering (seed is lost because it falls to the ground before or during harvesting); seed dormancy (some seed doesn't germinate for several years); uneven flower and seed development, which makes harvesting difficult; and sticky seed hairs that plug conventional harvesting equipment," says Thompson.

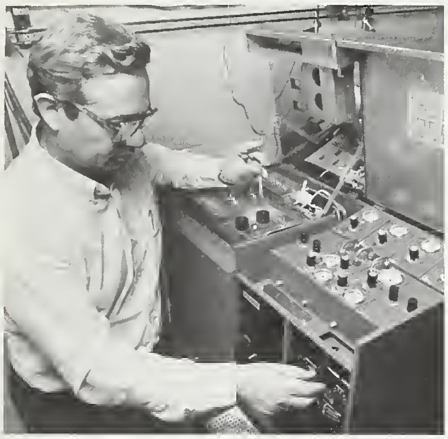
Weeds may also be a problem because cuphea is slow growing in its seedling stage and must compete with faster growing weeds.

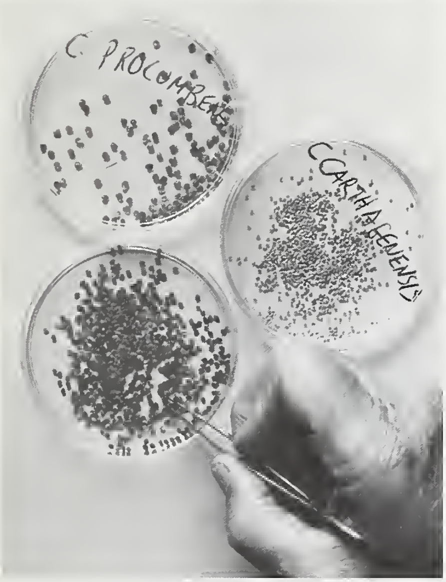
"With adequate, sustained research, we should be able to solve these problems just as scientists have done with other crops," says Thompson who works at the U.S. Water Conservation Laboratory.

Fortunately, cuphea possesses much genetic variability, which makes it easier for plant breeders to develop superior plants.

Of the 260 or so known cuphea species, some mature plants resemble an herb, others are grown as ornamental shrubs; some are self-pollinating, others are cross-pollinating; some are annuals while others are perennial; and some produce seed oil that has manufacturing potential, others produce oil having potential medical uses.

Thompson with cuphea collection in greenhouse. (0985X1006-22A)





Above, top: Chemist Robert Kleiman of the ARS Northern Regional Research Center, Peoria, IL, determines fatty acid composition of cuphea seed oil through gas chromatography. (1284X1835-12A)

Above: Cuphea seeds of different species are selected for germination studies aimed at increasing seed size. Currently, seed size varies so much by species that it can take anywhere from 7,000 to more than 50,000 seeds to make an ounce. (0985X1007-1A)

Some cuphea plants produce only 2 or 3 seeds per flower, others produce more than 100; some seeds germinate readily, others remain dormant for years; some have very small flowers, others are large and showy; some have deep purple flowers, some have white flowers, and others range between these colors; some have extremely sticky and hairy stems, leaves, flowers, and fruits, others are practically hairless.

Thompson has assembled a collection of 44 of the more promising species from Mexico and Central and South America for testing at the Phoenix laboratory. The three or four species native to the United States do not appear to have high enough potential for study at this time.

Cuphea doesn't seem to be particularly susceptible to any major diseases or insects, and it appears that seed production of 1 ton per acre will be possible, Thompson says.

He is looking for the best ones suited as parents for breeding and germplasm development programs. A major effort is underway to recombine and release new sources of genetic variability. The basic research will benefit plant breeders who are developing cuphea for growing conditions in other parts of the country.

T. Austin Campbell, ARS agronomist at Beltsville, MD, is developing annual species for humid and temperate climates. His research concentrates on conventional breeding and high-technology techniques such as propagating plants from single cells or from anthers to improve cuphea.

Robert Kleiman, ARS chemist at the Northern Regional Research Center, is chemically analyzing and evaluating original cuphea plant material and varieties produced through the breeding programs.

A unique three-way, equally funded program for developing cuphea, involving ARS, Oregon State University Agricultural Experiment Station, and member companies of the Soap and Detergent Association, is also in progress. The program is concentrating on determining yield potential and crop adaptability at 11 locations in Oregon, Arizona, Iowa, Illinois, Indiana, Maryland, Georgia, and Puerto Rico.

Thompson and other ARS scientists are also cooperating closely with scientists at the University of Arizona, Tucson, and Purdue University in Indiana. These projects are a result of interest in having cuphea available as a crop for their region's farmers.

Although ARS continues to expand its research and development program in cuphea, it will be several years before farmers can buy seed to plant. "If we successfully develop high-yielding plants that produce seeds containing, say 40 percent oil with at least 60 percent lauric acid, we could conceivably have a crop bringing farmers $300 to $400 per acre," says Thompson, "and I stress 'conceivable' because we still have much research to conduct.". New uses for the fatty acids in cuphea seed may be developed, and economic conditions may change, making the crop more or less valuable.—**Dennis Senft,** Albany, CA.

Anson E. Thompson is located at the U.S. Water Conservation Laboratory, 4331 E. Broadway Road, Phoenix, AZ 85040. ■

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Electron Beam Puts a Shine on Leather

Frank Scholnick always keeps a stylish pair of new shoes and a smart leather briefcase at work.

He is not a fashion model. Scholnick is a chemist on a special hides and leather research team of ARS scientists at the Eastern Regional Research Center in Philadelphia.

Scholnick's shoes and briefcase are eye-catching first samples of an imaginative part of the team's research—radiation-curing of leather.

The research team has figured out how to apply brief zaps of ultraviolet light or electron beam radiation to put finishes on leather. The radiation is less powerful than x rays and poses no hazard to people wearing the cured leather, says Scholnick.

The new leather treatment can offer "all the fashionable looks" on everything from wallets to suitcases, says Scholnick, as he shows off his samples to laboratory visitors.

Radiation-cured leather has excellent physical properties. Scholnick's sample pair of shoes are of an even tone of light brown soft leather. The briefcase is made of a rich dark brown leather with a semigloss finish. The new finishes are more scuff resistant than finishes applied by other methods, he says.

The treatment ingrains chemicals into leather moving through radiation equipment on a conveyor belt. Before entering the conveyor, the leather is covered with a wet film containing chemicals composed of small molecules such as acrylics. The irradiation solidifies the mixture by linking the small molecules into polymer chains that fix to the leather as a tough coating.

Such radiation curing saves at least 60 percent of the energy cost of conventional leather finishing and could result in considerable savings in plant space and labor, says Scholnick.

Commercially available radiation equipment, normally used to bond plastic coatings onto metal cans and some vinyl and wood products, was adapted for this project. The equipment is safe to operate. Built-in shielding protects workers so they need not wear protective clothing.

The hides and leather research team, formed and led for many years by the late Peter R. Buechler, an ARS chemist, is trying to wedge open a serious two-way squeeze on U.S. leather and tanning industries.

First, there is foreign competition. "Research helps return a competitive edge to U.S. leather industries. In recent years, we have sold most U.S. hides overseas and bought back leather products," says Scholnick. "This portion of the trade deficit is roughly $3.5 billion each year. Radiation curing can help U.S. manufacturers reduce the deficit by selling finished leather overseas."

Second, federal and state environmental agencies are toughening pollution regulations on the industries, he said. Radiation curing of leather is nonpolluting. For the first time, leather can be finished with no escape of solvent chemicals. Instead of evaporating, the chemicals become part of the coating.

Radiation curing has undergone initial testing in commercial tanneries at the A.C. Lawrence Leather Co. of Danvers, MA. Paul Finnegan, the firm's director of Environmental Affairs, said recently that the radiation-curing concept is "great for the industry, although it still needs some more refining for each type of leather and type of finish desired by

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consumers".—**Stephen Berberich,** Beltsville, MD.

Frank Scholnick is at the USDA-ARS Eastern Regional Research Center, 600 East Mermaid Lane, Philadelphia, PA 19118. ■

Chemist Frank Scholnick with examples of radiation-cured leather products. (1285X1379-11)

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Computer "Fingers" Grain Thieves

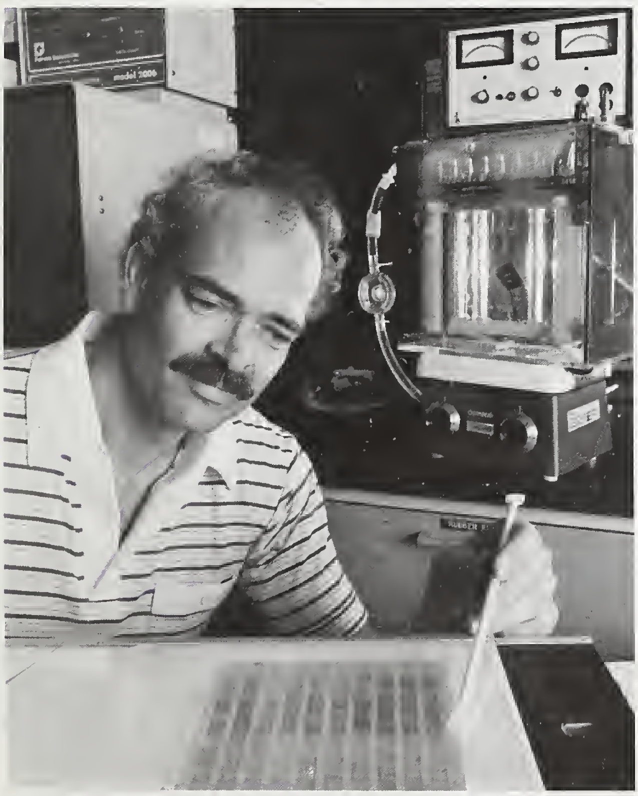
In June 1983, suspects in a grain theft were caught with five semitrailers of wheat near Atchison, KS. The wheat, worth more than $100,000, had been reported missing earlier from the Farmers Co-op Elevator of Atchison River Terminal.

Now it's relatively easy to identify thousand dollar bills when $100,000 is stolen from a bank. But grain has no distinguishing marks such as serial numbers or fingerprints. Or does it?

An expert witness was called to examine the samples. The witness was a computer using a new protein comparison technique that positively identified the grain in the trucks as being of the same variety as the grain in the Atchison River Terminal elevator.

George L. Lookhart, Agricultural Research Service chemist at the U.S. Grain Marketing Research Center, Manhattan, KS, presented in court the evidence obtained by the computer.

As Lookhart says, wheat varieties can be distinguished by a unique pattern, similar to a fingerprint, formed by separating either of two major proteins. The gliadin proteins were used to identify the wheat varieties in question. But the other major protein, the glutenin, can also aid in identification.



Chemist George Lookhart identifies wheat varieties by unique patterns formed when proteins are separated electrically into dark bands of varying intensity. (0985X1048-20)

The first step, a separation technique known as polyacrylamide gel electrophoresis (PAGE), is widely used in laboratories. It separates the gliadin proteins into bands based on their differences in molecular size and weight. Lookhart says, "After an electric current is passed through the gel and it is stained, it looks like gray Jell-O with dark bands that resemble rungs on a ladder."

Once the patterns are formed, Lookhart measures the distances and intensities of the bands and compares them with computer-stored data about the 88 most commonly grown U.S. wheat varieties.

He says this method is as accurate as using fingerprints to identify humans. "It's like having two people of the same sex, height, coloring, facial structure, body shape, and weight. How could you tell them apart based on their physical description? You would have to look further in their makeup for some distinguishing characteristic," says Lookhart.

However, the stakes are greater than just physical differences when identifying wheat flours for specific commercial purposes.

Identification problems became apparent when plant breeders began creating new varieties by crosses between wheat classes. Although PAGE cannot tell classes apart, it can identify a new variety regardless of its parentage once the protein patterns are established.

There is more at stake than simple identification. Wheat flours have different uses depending on their class. For example, hard wheat is used for breadmaking, soft wheat is used for cookies and crackers, and durum wheat is used for pastas.

Besides pointing the finger at grain thieves in the courtroom, the computer-aided PAGE method could be used by wheat breeders and USDA Plant Variety Protection officials who need to make positive identifications not easily done by visual examination.

"Speed is critical in this kind of work. And the computer coupled with PAGE doesn't let us down," says Lookhart. Although it takes about 6 hours to completely process one sample, it is possible to run as many as 80 during a day with the computer's help.

Co-developers of the computer-aided PAGE identification system were ARS researchers Berne L. Jones, Madison, WI, and Duane E. Walker, Manhattan, KS.—**Linda Cooke-Stinson**, Peoria, IL.

George L. Lookhart is located at the U.S. Grain Marketing Research Center, 1515 College Avenue, Manhattan, KS 66502 ■

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PATENTS

Double-Dip Keeps Papayas Fly-Free

A hot-water bath treatment to kill fruit fly larvae and eggs in papayas has been refined and combined with an objective ripeness test.

The papayas get two baths (in either water or oil), one for 30 to 60 minutes at 38°C to 45°C and one for 5 to 30 minutes at 45°C to 55°C.

Before or after the baths, papayas that are ripe enough to have full-blown fly infestations are identified by using a colorimeter to measure the yellowness of the fruit. Papayas turn yellow as they ripen.

Ripe papayas have to be rejected because by then fruit fly larvae will have had enough time to reach the center of the fruit, which doesn't get enough heat from this treatment to kill the larvae.

The heat and times are carefully chosen to kill larvae and eggs near the surface without damaging the fruit.

The 1½-hour maximum time required gives this method an advantage over the most promising legal fumigant, which requires a minimum of 48 hours.

This is a joint invention of the Agricultural Research Service and the University of Hawaii. (See *Agricultural Research,* February 1985, p. 12.)

For technical information, contact H. Melvin Couey, USDA-ARS Pacific Basin Area, P.O. Box 4459, Hilo, HI 96720. *Patent Application Serial No. 757,396, "A Quarantine System for Papaya."* ■

A Better Way to Wrap Vegetables

Lettuce, cauliflower, cabbage—all can be wrapped mechanically in heat-sealable film.

This invention combines a conveyor belt with a sealing assembly. Unlike other machines, which feed film intermittently for objects of a particular size and shape, this machine feeds film continuously and can wrap irregular-shaped vegetables such as cauliflower.

This method eliminates the need for trays used in some methods to provide a uniform size and shape for wrapping. It also protects the loose outer leaves of lettuce and cabbage by packaging them in one smooth operation, eliminating damaging transfers.

For more information, contact Coordinator, National Patent Program, USDA-ARS, Rm. 401-B, Building 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. *Patent No. 4,516,385, "Wrapping Machine."* ■

Low-Salt Foods

See *Low-Salt Soy Sauce Tastes Just as Good,* page 5, for information on *Patent No. 4,503,082, "Method for Reducing Sodium Content and Simultaneously Increasing Potassium Content of a Food."* ■

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A listing of all U.S. Department of Agriculture patents is available on request. If you are interested in applying for a license on a patent or receiving the catalog, write to the Coordinator, National Patent Program, USDA-ARS, Rm. 401, Bldg. 005, Beltsville, MD 20705.

Copies of existing patents may be purchased from the Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, Washington, DC 20231. Copies of pending patents may be purchased from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.